National Transportation Safety Board
Office of Research and Engineering
Washington, D.C. 20594

Performance Study

Specialist Report
Marie Moler

A. ACCIDENT

Location:	New Haven, CT
Date:	August 9, 2013
Time:	1121 EDT
Airplane:	Rockwell International 690B, Registration N13622
NTSB Number:	ERA13FA358

B. GROUP

No vehicle performance group was formed.

C. SUMMARY

On August 9, 2013, about 1121 eastern daylight time, a Rockwell International 690B, N13622, was destroyed after impacting two homes while maneuvering for landing in East Haven, Connecticut. The personal flight was conducted under the provisions of 14 Code of Federal Regulations Part 91. Instrument meteorological conditions prevailed and an instrument flight rules (IFR) flight plan was filed for the flight that departed Teterboro Airport (TEB), Teterboro, New Jersey, about 1049 and was destined for Tweed-New Haven Airport (HVN), New Haven, Connecticut.

Review of preliminary data from the Federal Aviation Administration revealed that at 1115:08, the flight was cleared for the instrument landing system (ILS) approach to runway 2, circle to land runway 20 at HVN by New York Approach Control (N90). At 1115:52 the pilot contacted HVN tower and reported seven and one-half miles from SALLT intersection. The HVN local controller instructed the pilot to enter a left downwind for runway 20. At 1119:36 the pilot reported to HVN air traffic control (ATC) that he was entering a left downwind for runway 20. HVN ATC cleared the pilot to land on runway 20. While circling to runway 20, the HVN tower controller asked the pilot if he would be able to maintain visual contact with the airport. The pilot replied "622 is in visual contact now". At 1120:59 the HVN air traffic controller made a truncated transmission with the call sign “622”. No further communications were received from the accident airplane. The last recorded radar target was at 1120:53, about 0.7 miles north of the runway 20 threshold indicating an altitude of 800 feet mean sea level.

D. PERFORMANCE STUDY

The performance study describes the accident airplane ground track, altitude, and speed, as well as the timing of select transmissions between air traffic control (ATC) and N13622. Radar data used in this study are primarily from the HPN ASR-9 (airport surveillance radar) en route to HVN and sampled at a frequency of every 4.5 seconds. The radar is approximately 40 nautical miles from the aircraft's final location. These data have approximately a 60 nautical mile (NM) range and an inherent uncertainty of ±2 Azimuth Change Pulses (ACP) = ± (2 ACP) x (360º/4096 ACP) = ±0.176° in azimuth, ±50 ft in altitude, and ±1/16 NM in range. However, the final five radar points are from the QVH ARSR-4 (air route surveillance radar) and are 12 seconds apart. The QVH radar is located 25 miles from the accident location.

Times in the study are reported in EDT.

Weather Observation

Weather at the time of the accident was surface winds from 170° at 13 kts, gusting to 19 kts, temperature 24°C, and pressure 1012.3 hPa. At 435 ft MSL, weather was winds from 190° at 19 kts, temperature 23°C, and pressure 1000 hPa. At 900 ft MSL, the wind was from 205° at 30 kts, temperature 22°C, and pressure 984 hPa. HVN reported IFR (instrument flight rules) ceiling conditions with light rain. Visibility was 9 miles with an overcast ceiling at 900 ft agl (above ground level).

See the Meteorological Factual report for more detailed weather information.

Airplane Ground Track, Altitude, and Airspeed

The flight originated from Teterboro Airport (TEB) and at 1115:08 was cleared for an ILS (instrument landing system) approach into Tweed-New Haven Airport (HVN). The radar path and ATC communications can be seen in Figure 1. The airplane turned from an earlier 155° heading to a 0° heading (see Figure 2) and was instructed onto a downwind for runway 20. Surface winds at the time of the accident would have resulted in about an 11 kts tailwind if landing on runway 2 (see Figure 3). At 1119:24 the aircraft's recorded altitude passed below the overcast ceiling reported at HVN. The aircraft's location at this time is approximately four miles and 1.5 minutes from its final radar return.

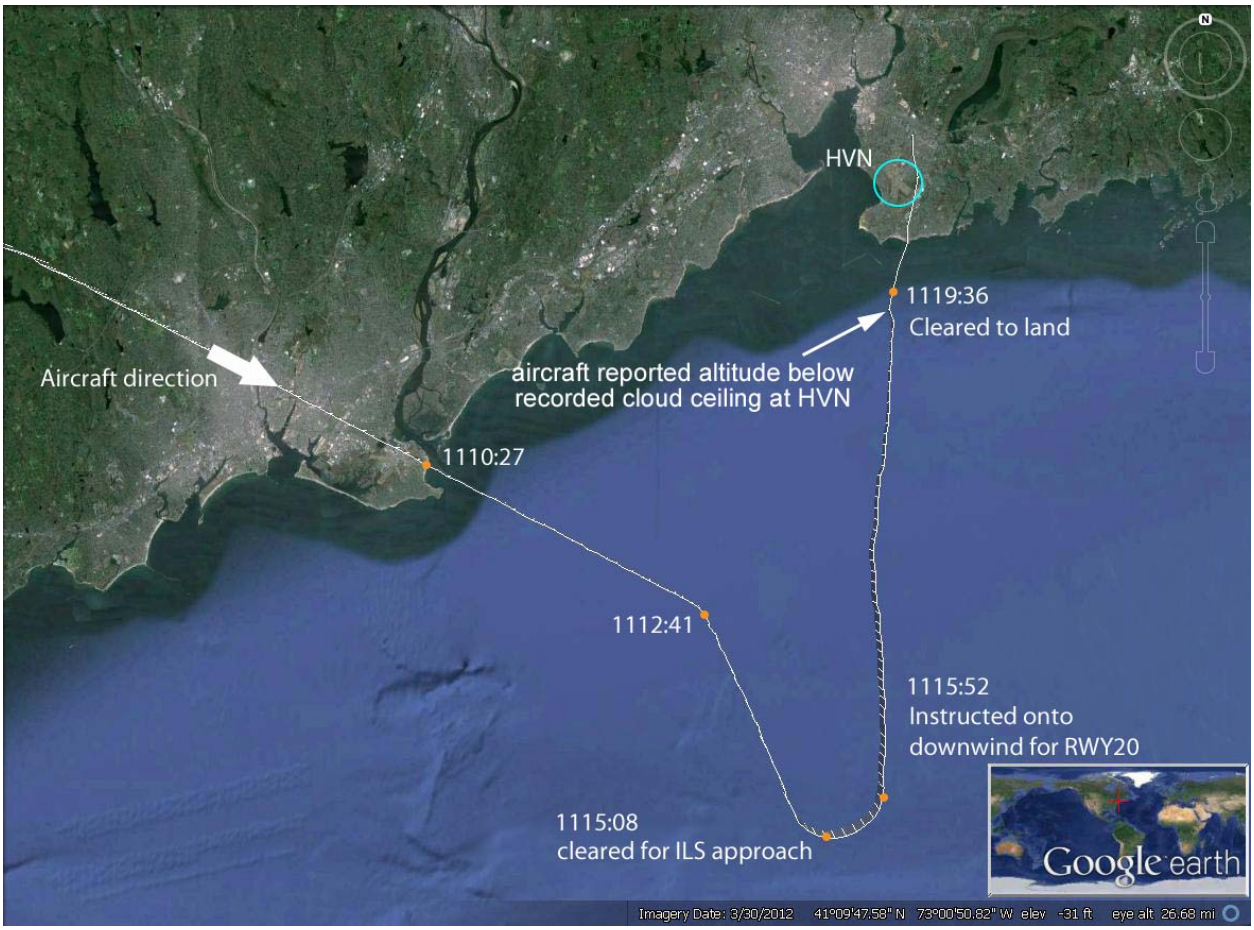

Figure 1. Aircraft radar path and ATC communications.

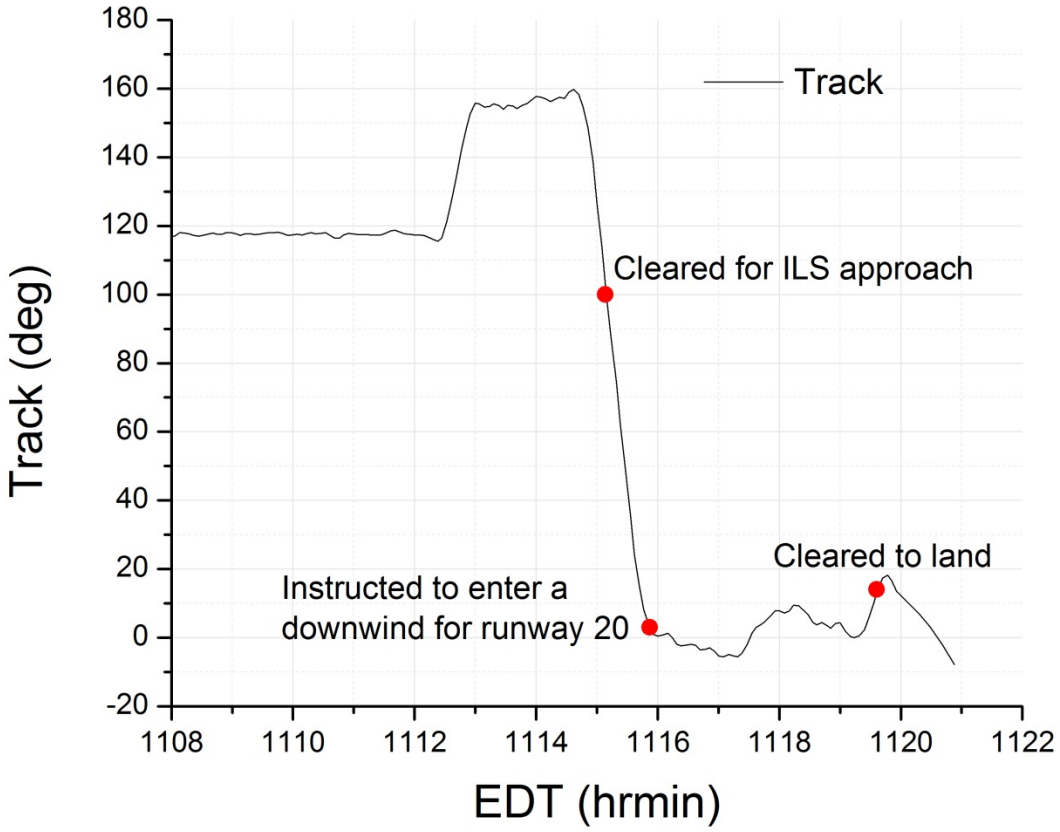

Figure 2. Aircraft track heading and ATC communications.

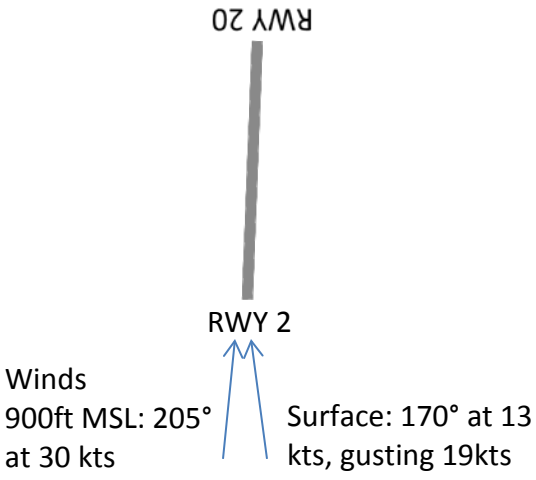

Figure 3. Winds and HVN runways.

The aircraft was cleared for landing at 1119:32. Radar near this time records the aircraft at 700 ft mean sea level (MSL). Tweed-New Haven Airport is 12 ft above mean sea level. As shown in Figure 4, the aircraft continued along the eastern side of runway 20 and at 1120:41 was asked if he could maintain visual of the runway which the pilot confirmed. As the aircraft was on the final portion of the downwind, its ground track was between 0.4 NM (2,430 ft) and 0.48 NM (2,916 ft) away from the runway as shown in Figure 5. The last radar return was at 1120:53. Notice the last five radar returns (white vertical lines) in Figure 4 correspond with the 12 second radar and are farther apart than earlier radar returns. The airplane impacted the ground at 41°16'46.49"N / 72°53'9.51"W (blue square in Figure 4).

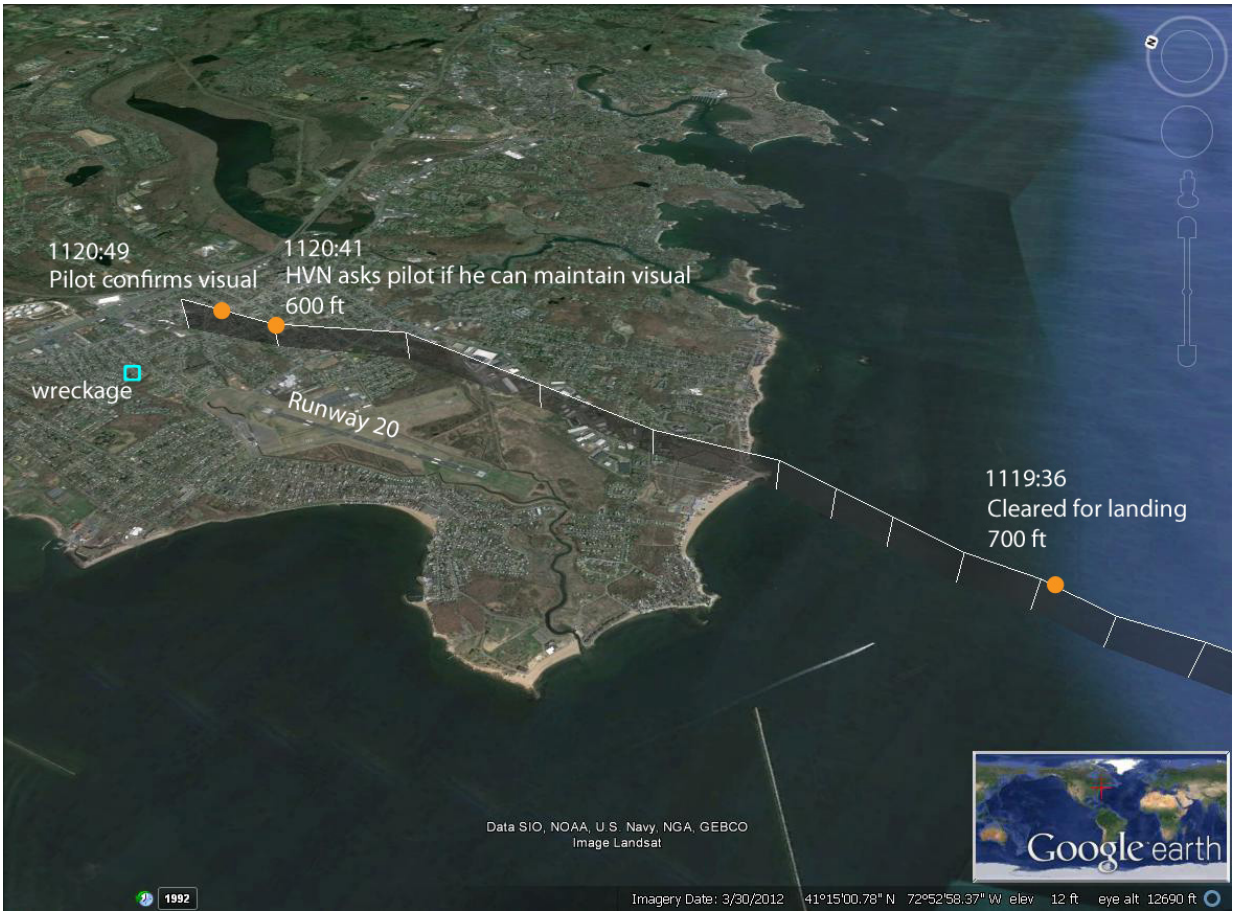

Figure 4. Aircraft radar path and ATC communications for final approach.

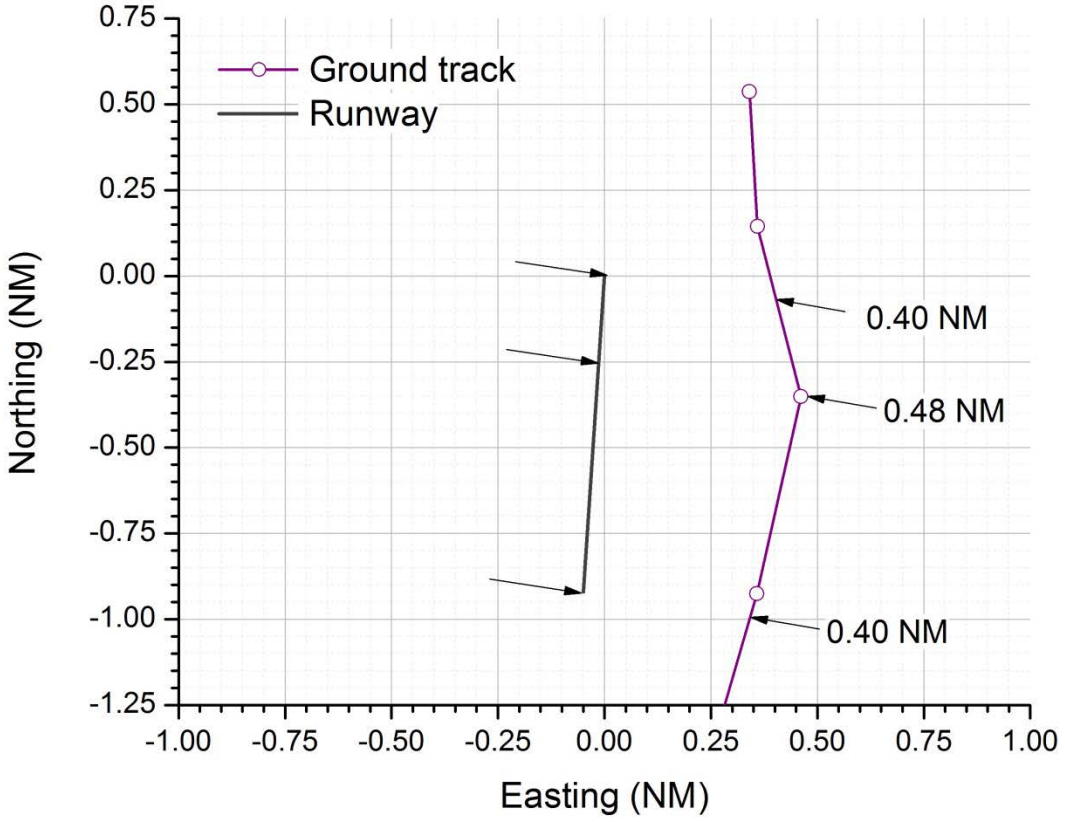

Figure 5. Aircraft ground path with relation to runway.

The aircraft began descending during the downwind leg of the flight, starting at 1117 as shown in Figure 6. At about 1119:30 the aircraft leveled off between 600 and 700 ft until its last radar return at 1120:53 at 800 ft. The aircraft's glide slope from 1117 to 1119 was approximately 5º.

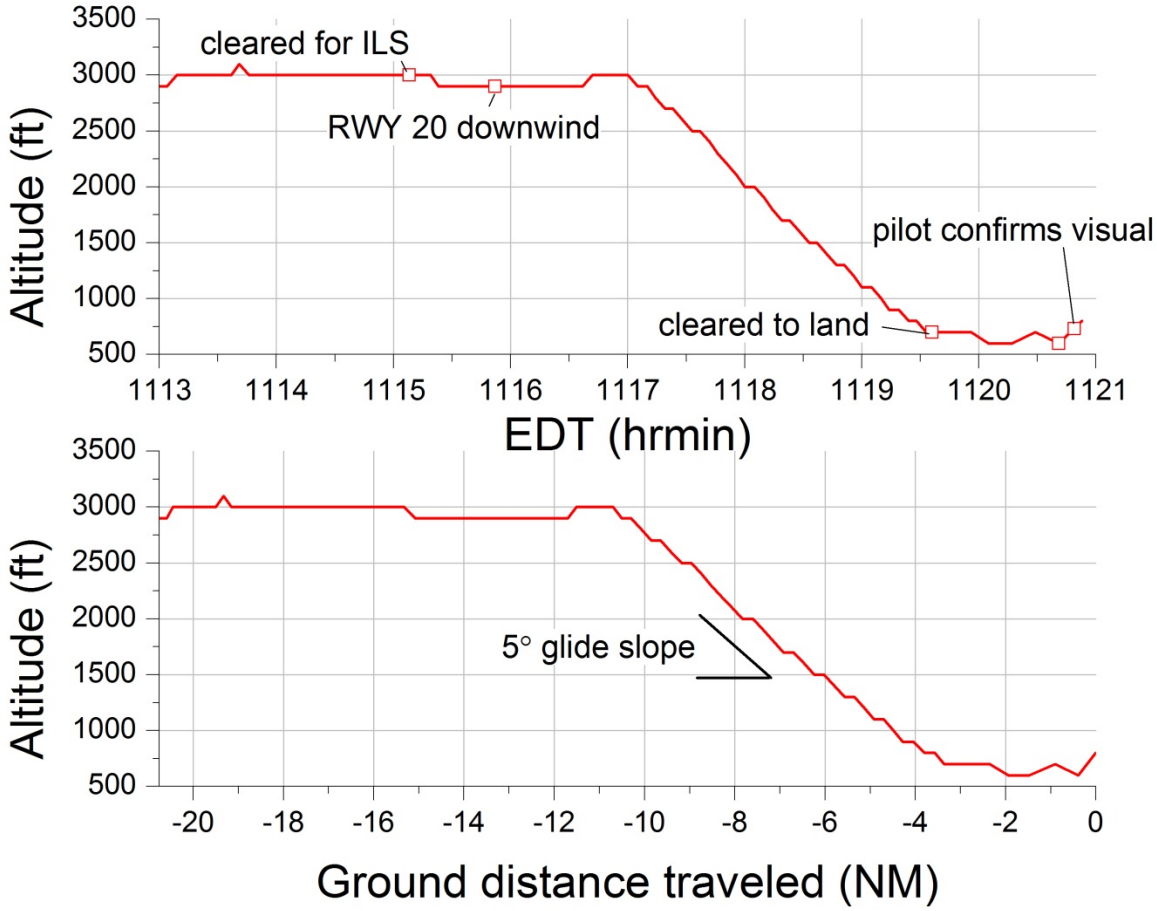

Figure 6. Aircraft altitude and glide slope.

Groundspeed, calibrated airspeed, and true airspeed were calculated using the radar latitude and longitude and the reported winds at the time of the accident and are shown in Figure 7. Speed calculations are approximate averages of the aircraft's speed between radar data points.

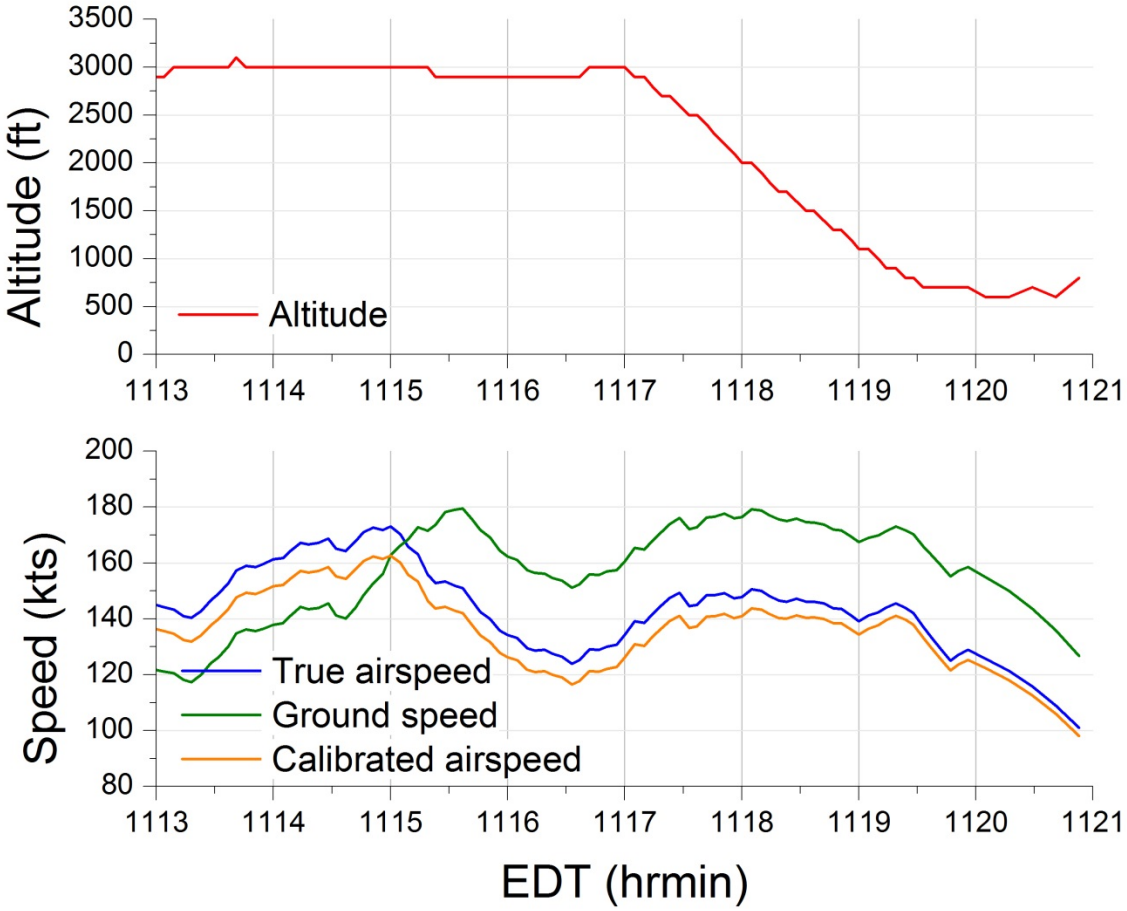

Figure 7. Aircraft altitude, calibrated airspeed, groundspeed, and true airspeed.

During the descent from 3000 ft, the aircraft's airspeed was about 140 kts. The aircraft reduced speed as it leveled off during the final portion of the downwind and at the last radar return the estimated airspeed (both true and calibrated) was approximately 100 kts. True and calibrated airspeeds were converging as the aircraft descended to land.

Banked Turn Calculations and Aircraft Stall

Assuming that the pilot intended to turn from the current heading onto one in line with runway 20, the aircraft would need to make a near 180° turn with a radius of 900 ft (diameter ~⅓ NM) as shown in Figure 8. The last airspeed approximation from the radar trajectory was 100 kts. In the equation below, θ is the bank angle necessary to complete a turn of radius R and airspeed V (g is the gravitational constant, 9.81 m/s^2), assuming there are no winds.

$$\theta = tan^{-1}\left(\frac{V^2}{gR}\right)$$

Applying a speed of 100 kts and a radius of 900 ft, the necessary bank was calculated to be about 45° for the lift to balance the centripetal force of the turn and keep the aircraft aloft. However, this is a kinematic equation and does not guarantee that a particular aircraft would be able to generate the necessary lift at that speed. The winds from the south would tend to push the airplane to the north during the turn and the track would not be a semicircle, but that would not change the required constant bank angle calculated above. If the pilot performed a circular turn around a fixed point, he would have required a higher bank angle initially on the downwind leg, but a lower bank angle on the return upwind leg.

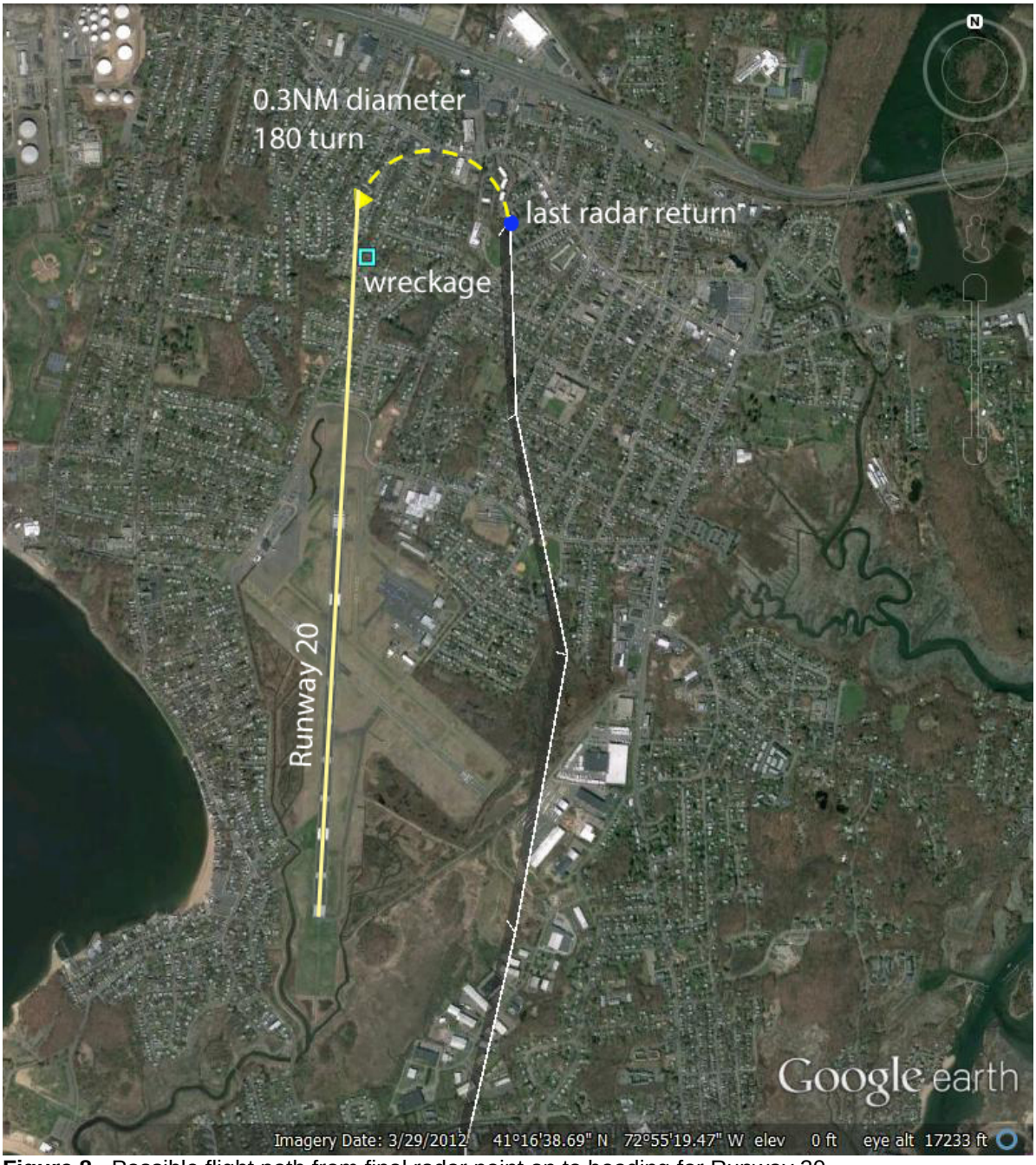

Figure 8. Possible flight path from final radar point on to heading for Runway 20.

Figure 9 below is a plot from the Pilot's Operating Handbook for the Rockwell Commander 690B. The figure can be used to determine how increasing aircraft bank angle increases stall speeds. While the aircraft's thrust, weight, and configuration were not definitively known, the trend can be determined. A 9,500 lbs aircraft at cruise would stall at 78 kts wings level (blue line in Figure 9), but at 84.5 kts in a 30° bank (the dotted line example in Figure 9). Extrapolating to a 45° bank (orange line Figure 9), the stall speed increases to 94 kts. For a 9,500 lbs aircraft in the landing configuration (full flaps 40°), the stall speed at 45° bank is 88 kts. Using the plot to determine the increase in stall speeds for a variety of configurations reveals that a 45° bank will increase the stall speed by about 20% compared to the level flight speed. Additionally, the model does not account for uncoordinated flight, such as if the aircraft was slipping or cross-controlled during the turn from the downwind onto final. If the aircraft was in uncoordinated flight, its angle of attack would most probably be greater on one of the wings, further decreasing the stall speed.

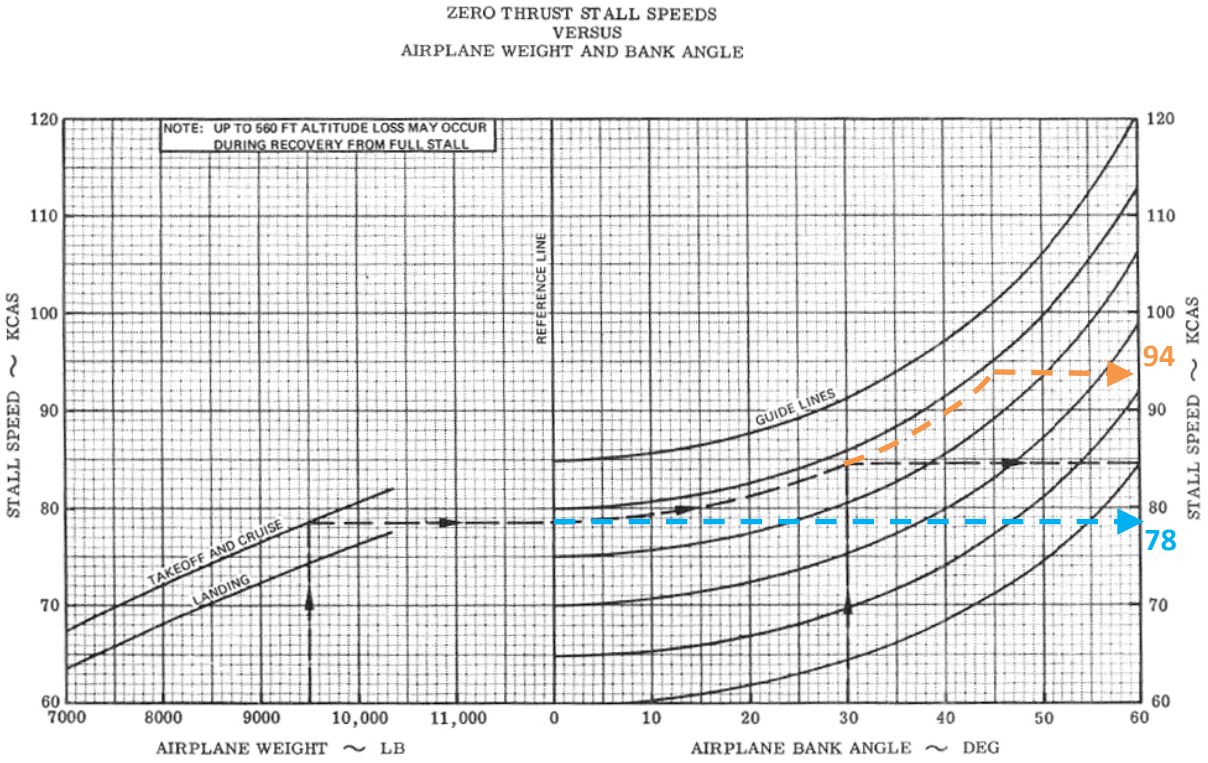

Figure 9. Airplane weight versus stall speed and bank angle versus stall speed from the Pilot's Operating Handbook for the Rockwell Commander 690B.

E. CONCLUSIONS

The accident aircraft was instructed to enter a left downwind for runway 20 at 1115:52. The aircraft descended from 3,000 ft to about 700 ft on a 5° glide slope. During the final 1 ½ minutes of flight the aircraft maintained an altitude between 600 and 800 ft and airspeed was reduced

from about 140 kts to 100 kts and appeared to be still decreasing. The downwind portion of the flight parallel to runway 20 was between 0.4 NM and 0.48 NM from the runway center.

The aircraft's close proximity to runway 20 during the downwind leg of the approach would have required a tight turn onto final. The steep bank angle necessary for the turn combined with the aircraft's low airspeed greatly increased the likelihood of stall, which would have occurred at a speed higher than the pilot would have expected.

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